Feeling healthy versus being healthy: change and stability in older people s self-rated health

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3 Is self-rated health still sensitive for changes in disease and functioning among nonagenarians?

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Abstract

Objectives: With age, there is an increasing gap between relatively stable levels of self-rated health (SRH) and actual health status. This study investigates longitudinal changes in SRH and examines its sensitivity to changes in chronic conditions and functioning among people aged 90 and over.

Methods: In the Vitality 90+ Study, questionnaires were sent to all people aged 90 years and over living in Tampere, Finland. Included were respondents who provided data on the 2001 measurement and at least one follow-up measurement in 2003, 2007 or 2010 (N=334). Generalized Estimating Equations analyses examined longitudinal change in SRH and the predictive value of number of chronic conditions and a functioning score, based on five activities.

Results: Within two years, most people (56.3%) had unchanged SRH, but declined SRH (22.3%) was associated with worse baseline functioning and declined functioning. Clear declines in SRH after six and nine years were associated with increased chronic conditions (OR=1.23) and decreased functioning (OR=1.28). The impact of chronic conditions and functioning was smaller among institutionalized people (chronic conditions OR=0.90; functioning OR=1.18) than among people living independently (chronic conditions OR=1.30; functioning OR=1.44).

Discussion: SRH among nonagenarians was sensitive to changes in the number of chronic conditions and functioning, although more pronounced on the longer than on the shorter term.

Introduction

Self-rated health (SRH) measures the general perception of an individual's health status, and is one of the most widely used indicators for health status[1]. Its popularity lies both in its ease of assessment and its well-established predictive value for several future health outcomes among older people, such as morbidity, physical functioning, health care use and mortality[2-4]. Predictors of SRH include physical as well as socioeconomic, social, cognitive and emotional factors[5-7].

At the same time, there is ongoing debate on whether SRH should be used as a measure of global health[8,9]. According to the structure of health status by Johnson & Wolinsky[10], and confirmed by many other studies, chronic diseases have a direct effect on SRH and an indirect effect through functional limitations[5,10-13]. But the link between symptoms, diagnosed conditions and functional status on the one hand and SRH on the other hand weakens with age[13-15]. A seeming contradiction arises between people's physical health on the one hand, which often declines with increasing age, and their level of subjective health on the other: the 'paradox of aging'. SRH shows a rather strong stability, as opposed to self-assessed change in health (i.e. people are asked to report whether their health had declined, improved or remained stable) and changes in disease status and functioning[16,17]. In addition, given a comparable level of diseases and functioning, older olds rate their health more positively than younger olds[18], and are less likely to change their evaluation of health in response to changing disease status[19].

This paradox of a relatively optimistic view on health may result from the aging process, but also from cohort differences and selective survivorship[20]. As a main explanation most studies put forward mechanisms of adaptation in response to health declines, for example social comparison mechanisms[21]. Jylhä has proposed a model for the assessment of general health status, indicating that SRH is influenced by contextual frameworks of evaluation[1]. Three steps were described that are necessarily included in self-evaluations. Firstly, respondents need to select those health-related aspects that they think are relevant when describing their health. In addition, they need to combine those aspects that are deemed relevant and view them in reference of other factors to come to a valuation of 'my health'. Finally, they have to choose one of the preset response options that best fits this valuation. Especially the first two steps may be influenced by people's age and previous health experiences. Studies have shown that the health aspects that older people take into account to some extent differ from the health aspects that younger people consider when rating their health[22-24], which suggests an altered meaning of health[25,26]. In addition, older people may downgrade aspirations and expectations regarding health[27] or compare themselves downwardly to others who are worse off[14,28]. These are desirable adaptive responses to health decline but they challenge the interpretation of SRH as a proxy for objectively measured health status across age groups.

Probably, the discrepancy between SRH and objectively measured health status reaches a maximum in the oldest old, e.g. those aged 90 and over. The few studies conducted among nonagenarians showed that more than half rate their health as good or very good, in spite of

numerous health problems[29]. Still, SRH among nonagenarians is associated with specific chronic diseases[30] and even with survival[31-33]. Thus, it seems that having good SRH is still predictive for better health outcomes, but only one study focused on change in SRH[31] and no studies have examined its sensitivity to health decline. The main goal of this paper is to study longitudinal change in SRH and the predictive value of decline in health and functioning on decline in SRH.

Two factors that may influence the extent to which health decline is reflected in SRH are taken into account. Depressive symptoms are prevalent among the oldest old, and are associated with SRH and declines in SRH[30,34]. As aging is often accompanied with declining physical health, good SRH may increasingly represent psychosocial well-being[25,35]. Therefore, depressive symptoms may directly affect SRH. In addition, when compared to non-depressed individuals at an equal morbidity level, depressed individuals rated their health worse[36]. This may indicate that depressed people view their health in a more negative light, or that coping strategies are influenced by depression. Whether depression also moderates the effect of diseases and functioning on SRH in the very old has not been studied previously.

Living situation plays an important role in the health of older people[37] and around 40% of nonagenarians live in institutions[38,39]. Studies have consistently shown that disability, cognitive impairment and chronic conditions are associated with transitions to institutions[40-42]. This is in accordance with Andersen and Newman's health care utilization hypothesis: people's living situation is adjusted according to their needs, if possible[43]. One study did not find a significant association between more objective measures of health and SRH among the institutionalized[44]. A more recent study did report this association but also found that institutionalized people may rate their health more positively compared to community-dwellers, given a certain health state[45,46]. It might be that since people in institutions represent people with more advanced ill health, they engage more often in downward social comparison with people who are worse off, resulting in more positive self-ratings[28,47]. In addition, further health decline may have a smaller impact on their SRH as compared to community-dwelling people, because care may be already facilitated in institutions. A stronger association between SRH and health decline may be expected as well: health changes among institutionalized people may represent a terminal decline more often, and thus may affect SRH more strongly as compared to the less severe health changes that are experienced by people living at home.

Given the aging paradox - where older olds seem to rate their health differently than younger olds, more empirical knowledge is needed on the usefulness of SRH among the very old. This study examines in nonagenarians the ability of SRH to reflect changes in underlying health status, without specifically addressing the mechanisms underlying this paradox. More specifically, our aims were to investigate 1) longitudinal change in SRH among people aged 90 and over, 2) the sensitivity of SRH to reflect changes in chronic conditions and physical functioning and 3) whether depression and living situation moderate the association between chronic conditions and functioning and SRH. Data originate from the Vitality 90+ Study, with a target population of all people aged 90 and over in Tampere, Finland. Results obtained in

this study will improve the understanding of the extent to which SRH, a simple and pragmatic measure of health status, reflects underlying health status in very old age.

Methods

Study population

The Vitality 90+ Study is a prospective multidisciplinary population-based study of people aged 90 years or over in Tampere, the third largest city in Finland. The aims of this study are to explore well-being and functioning among people aged 90 years and over and to assess predictors of longevity and healthy aging[39,48]. Six waves of data collection have been conducted through mailed surveys in 1996, 1998, 2001, 2003, 2007 and 2010. Up until 1998, only those nonagenarians who were community-dwelling were included. Therefore, the current study uses data from the 2001 data collection onwards, including people living independently as well as people in assisted living facilities, residential homes or hospitals. Each wave was approved by the Research Ethics Committee of the City of Tampere.

In 2001, 1129 people were approached with a mailed questionnaire, and 892 people responded (response rate 79%). In 2003, 485 of them responded for the second time. In 2007, 113 responded and in 2010, 36 responded. Mortality was by far the most important cause of attrition. In total, this resulted in 1526 completed questionnaires. First, because this study focuses on how people rate their own health, the analyses only included questionnaires from people who answered themselves or who received help in reading the questions and/or writing the answers. When questionnaires were answered by someone else they were excluded from further analysis (380 questionnaires). Questionnaires with missing answers on self-rated health (19 questionnaires) were also excluded. Second, questionnaires of respondents who did not respond both to the 2001 questionnaire and at least one other wave were excluded (366 questionnaires). The final sample consisted of 761 questionnaires from 334 persons (2001: n=334; 2003: n=327; 2007: n=79 and 2010: n=21).

Measures

Age and gender were retrieved from the municipal registries. *Self-rated health* was assessed by asking respondents: 'How would you rate your current health? Is it (1) very good, (2) fairly good, (3) average, (4) fairly poor, or (5) poor?' Poor SRH was defined as either fairly poor or poor SRH. Good or average SRH was defined as very good, fairly good or average SRH.

The presence of the following *chronic conditions* was assessed by asking: 'Has your physician told you that you have any of these conditions?' cardiovascular disease, atherosclerosis, stroke, diabetes, arthritis (rheumatoid arthritis and osteoarthritis), Parkinson's disease, hip fracture and dementia or memory problems. These eight conditions were considered chronic, hence if a disease was mentioned once it was considered present at all follow-up measurements. It was decided to include dementia in the disease count because it is likely taken into account

by the respondents as a condition that affects their health. The inclusion criterion that people should be able to fill in the questionnaire themselves excludes most people who suffer from severe cognitive impairments. Those with mild or moderate cognitive impairment may still be present in the study, but it was shown that SRH still predicts mortality in this group[49], indicating that health ratings are likely to be relevant among those people.

To measure *functional status*, five activities were listed in the questionnaire; moving indoors, walking 400 meters, using stairs, dressing and undressing and getting in and out of bed. Respondents were asked whether they could perform these activities with options 1 'yes, without difficulty', 2 'yes, with difficulty'. 3 'only if someone helps' and 4 'no, I cannot'. All responses were summed to obtain a score between 5 (best functional status) and 20 (worst functional status) which was used in the analyses. Crohnbach's alpha of this sum score in our sample was 0.83.

The presence of *depression* was assessed by asking 'Has your physician told you that you have depression/ depressiveness?'. *Living situation* was asked in the questionnaire making a distinction between 'private apartment or house', 'assisted living facility', and 'institution'. Across all measurement waves, 9.2% lived in assisted living facilities. Similarly to those living in an institution, their environment consists for the larger part of older people. We hypothesized that this might lead to increased downward social comparison, and in turn to better health ratings. Therefore, we combined these two categories.

Statistical analysis

Data were analyzed by using Generalized Estimating Equations (GEE)[50]. This regression analysis is suitable for longitudinal data, because it accounts for within-individual correlation in the outcome measure. The regression coefficient estimated with GEE analysis reflects both the cross-sectional and the longitudinal part of the association between the predictor and outcome measure. A time indicator with values 0, 2, 6 and 9 was constructed, representing the intervals between the study years 2001, 2003, 2007 and 2010.

Logistic models were applied, studying the effect on poor SRH. This was done because a decline from good or average to poor SRH may indicate a more substantial drop in SRH, as opposed to for example a decline from very good to fairly good. In addition, a detrimental effect of chronic conditions and functioning may become more apparent in the prevalence of poor SRH. However, SRH was fairly normally distributed, and to avoid missing information from changes across all five categories a linear model was also applied[51-53]. Exchangeable and unstructured correlation matrices were selected for the logistic and linear models, respectively.

First, the time indicator was examined as a predictor of SRH, adjusted for baseline age and gender. A significant effect indicated a change in SRH within individuals over time. Second, time-varying measures of the number of chronic conditions and functional status were added to the model as predictors. If time lost its predictive value in the model, we concluded that any changes in SRH could be explained by changes in health status. Additionally, we examined if the predictive value of chronic conditions and functional status diminished or increased over

time, by including interaction terms of these variables with time. Third, time-varying measures of depression and living situation were entered to investigate whether they had an effect on SRH. Finally, product terms were included, multiplying the number of chronic conditions and functional status with the dichotomous variables depression and living situation to examine their effect on the association of SRH with chronic conditions and functioning.

The level of statistical significance was $p < 0.05$ for main effects, and $p < 0.10$ for interaction effects, since the power of statistical tests for higher order terms is generally lower than for first-order terms[54,55].

Results

Descriptives

Table 1 shows that excluded respondents (n=558) were older, more often lived in institutions, and had worse self-rated health than those included in the analyses (n=334). The prevalence of most chronic conditions was higher among excluded people and they had worse functioning at baseline.

Characteristics of the sample in each wave are shown in Table 2. At baseline, most nonagenarians rated their health as average (48.5%), and fairly good or very good health (36.5%) was more common than fairly poor or poor health (15.0%). An increase in the number of chronic conditions and a strong decline in functioning were observed. In particular the prevalence of arthritis and hip fracture increased, and dependency in walking 400 meters and using stairs showed the largest absolute increases. Although increased chronic conditions and declined functioning are apparent across all waves, only a small shift was observed in the SRH responses. This may already indicate that SRH is not that sensitive to underlying health problems. Only in the small sample that survived to 2010, a clearly worse SRH can be observed.

Analysis of change and stability in SRH

Figure 1 shows the distribution of SRH responses, categorized by number of years of follow-up. SRH remained more or less the same in people who were followed between 2001 and 2003, although individual changes are masked by this group-level stability: 56.3% did not change their health rating, while 22.3% declined and 21.4% improved. After six years, 36.7% showed a decline in SRH and after nine years this percentage had increased to 52.4%.

Table 1. Baseline characteristics of the study sample and non-response analysis[a]

	Study sample, N=334		Excluded, N=558[b]		
	% / median	n / range	% / median	n / range	P[c]
Age	91	90-104	92	90-106	<0.001
Female gender	79.9	267	81.4	454	0.599
Living in own home	80.5	269	38.2	213	<0.001
Depression	19.8	65	26.4	143	0.027
Self-rated health					
1=Very good	3.9	13	4.0	17	<0.001
2=Fairly good	32.6	109	25.3	107	
3=Average	48.5	162	39.5	167	
4=Fairly poor	12.0	40	21.3	90	
5=Poor	3.0	10	9.9	42	
Chronic conditions (0-8)	1	0-6	2	0-7	<0.001
CVD	48.2	159	56.9	308	0.014
Atherosclerosis	16.6	54	17.3	92	0.852
Stroke	4.5	15	10.0	54	0.004
Diabetes	8.2	27	12.5	68	0.056
Parkinson's disease	1.2	4	3.1	17	0.109
Arthritis	46.0	150	36.8	199	0.008
Hip fracture	12.7	42	20.3	110	0.004
Dementia	24.0	79	54.7	296	<0.001
Functional status (5-20)	7	5-20	12	5-20	<0.001
Dependency in:[d]					
Moving indoors	2.1	7	30.1	166	<0.001
Walking 400 meters	29.3	96	62.5	338	<0.001
Using stairs	26.1	87	63.6	348	<0.001
Dressing/undressing	4.5	15	42.5	233	<0.001
Getting in/out of bed	1.8	6	30.0	165	<0.001

[a] Sample originates from the Vitality 90+ Study, Tampere, Finland

[b] Reasons for exclusion were proxy answers on all waves (186 people), missing data on SRH on all waves (11 people) or having only one measurement (361 people).

[c] P values were obtained with chi-square and t-tests.

[d] The percentage who answered 'only if someone helps' or 'no, I cannot'.

Table 2. Characteristics of the sample in each measurement wave[a].

	2001	N=334	2003	N=327	2007	N=79	2010	N=21
	% / median	N / range	% / median	N / range	% / median	N / range	% / median	N / range
Age	91	90-104	93	92-106	97	96-105	99	99-106
Female gender	79.9	267	79.5	260	82.3	65	81.0	17
Living in own home	80.5	269	66.7	218	51.9	41	61.9	13
Depression	19.8	65	21.7	70	10.1	8	18.8	3
Self-rated health								
1=Very good	3.9	13	3.1	10	1.3	1	0	0
2=Fairly good	32.6	109	35.2	115	29.1	23	19.0	4
3=Average	48.5	162	45.0	147	46.8	37	57.1	12
4=Fairly poor	12.0	40	13.5	44	19.0	15	9.5	2
5=Poor	3.0	10	3.4	11	3.8	3	14.3	3
Chronic conditions (0-8)	1	0-6	2	0-6	2	0-6	3	0-6
CVD	48.2	159	59.9	194	58.2	46	50.0	9
Atherosclerosis	16.6	54	26.6	86	19.0	15	25.0	4
Stroke	4.5	15	7.1	23	5.1	4	5.9	1
Diabetes	8.2	27	11.2	36	12.7	10	18.8	3
Parkinson's disease	1.2	4	2.2	7	0.0	0	0	0
Arthritis	46.0	150	55.2	180	69.6	55	81.0	17
Hip fracture	12.7	42	20.1	65	34.2	27	63.2	12
Dementia	24.0	79	41.6	134	45.6	36	47.1	8
Functional status	7	5-20	8	5-20	10	5-20	12	5-18
Dependency in:[b]								
Moving indoors	2.1	7	8.0	26	14.1	11	10.0	2
Walking 400 meters	29.3	96	43.4	141	52.6	41	71.4	15
Using stairs	26.1	87	41.5	134	55.1	43	66.7	14
Dressing/undressing	4.5	15	12.8	42	21.5	17	19.0	4
Getting in/out of bed	1.8	6	7.3	24	13.9	11	9.5	2

[a] Samples originate from the Vitality 90+ Study, Tampere, Finland

[b] The percentage who answered 'only if someone helps' or 'no, I cannot'.

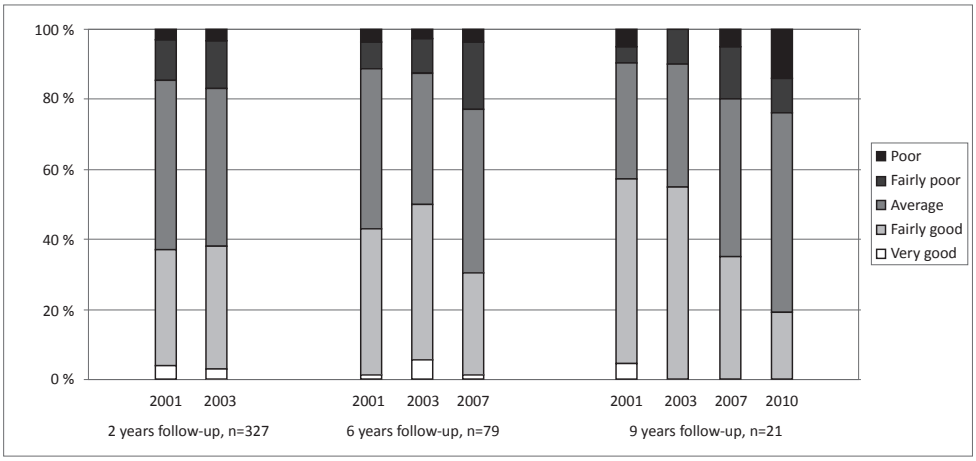

Figure 1. Distribution of self-rated health responses, according to length of follow-up

A significant linear association between time (in years) and poor SRH was found (first column, Table 3). The prevalence of poor SRH increased with follow-up duration, although the odds ratio for nine years of follow-up did not reach statistical significance. The time-effect disappeared after adding the health variables, indicating that worse SRH over time can be explained by worsened functional status and increases in chronic conditions. Number of chronic conditions and functional status both were associated with poor SRH, even though negative interactions with time indicated that they became less strong predictors of SRH with longer follow-up (not shown). The results further showed that when functional status was taken into account higher age was associated with better SRH.

Depression significantly predicted poor SRH (fifth column, Table 3). Living in an institution was not associated with poor SRH, in the adjusted model or in a model without chronic conditions and functioning (OR=1.40; 95% CI 0.86-2.27). The odds ratios for the product terms of depression with functional status, and for living in an institution with chronic conditions and functioning were lower than 1 and statistically significant.

In a linear model, similar results were found with respect to the effect of time. However, the effects of chronic conditions and functioning were weaker and non-significant in most cases. Only functional status led to poorer SRH in the fully adjusted model (last column, Table 3). No differences were found with respect to living situation, but there was an amplified negative effect of chronic conditions on SRH for those with depression.

Stratified results are shown in Table 4, and demonstrate that poor functioning was more detrimental for SRH in non-depressed nonagenarians. Still, additional analysis showed that depression was related to poorer SRH across all levels of functioning. The negative impact of chronic conditions on SRH was only statistically significant among those living at home. The effects of functional status and depression on SRH were smaller in people living in an institution, as compared to people living at home. Since the prevalence of dementia was higher among institutionalized people (44.9% vs. 30.1%), and dementia may be more severe among the

Table 3. Associations of chronic conditions and functional status with SRH, based on Generalized Estimating Equations analysis (GEE).

	Logistic models[a]										Linear model	
	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P	B (95% CI)	P
2003 vs. 2001	1.15 (0.83;1.60)	.397										
2007 vs. 2001	1.85 (1.12;3.05)	.016										
2010 vs. 2001	2.10 (0.74;5.95)	.163										
Time (0-9 years)			1.10 (1.02;1.19)	.020	1.03 (0.93;1.14)	.634	0.92 (0.81;1.04)	.181	0.95 (0.84;1.08)	.491	-0.03 (-0.11;0.06)	.520
Baseline age	0.92 (0.81;1.04)	.183	0.92 (0.81;1.04)	.180	0.93 (0.82;1.05)	.236	0.85 (0.74;0.97)	.019	0.85 (0.74;0.98)	.020	-0.00 (-0.07;0.06)	.932
Female gender	1.39 (0.79;2.43)	.251	1.39 (0.79;2.43)	.249	1.37 (0.77;2.45)	.284	1.23 (0.68;2.24)	.489	1.28 (0.72;2.28)	.409	-0.12 (-0.56;0.32)	.605
Nr of chronic conditions (0-8)					1.44 (1.23;1.68)	<.001	1.23 (1.02;1.48)	.030	1.18 (0.98;1.43)	.088	0.00 (-0.31;0.31)	.988
Functioning (5-20)							1.28 (1.20;1.36)	<.001	1.29 (1.20;1.38)	<.001	0.07 (0.00;0.13)	.039
Depression									2.05 (1.22;3.45)	.007	0.69 (-0.09;1.48)	.084
Institutionalized[b]									0.62 (0.34;1.15)	.126	-0.25 (-1.07;0.57)	.552
Product terms:[c]												
Depression*chronic conditions									0.92 (0.64;1.31)	.632	0.37 (0.01;0.73)	.044
Depression*functioning									0.85 (0.76;0.95)	.005	0.09 (-0.04;0.22)	.170
Institution*chronic conditions									0.62 (0.40;0.94)	.024	-0.20 (-0.76;0.37)	.498
Institution*functioning									0.83 (0.74;0.93)	.001	-0.02 (-0.12;0.09)	.767

[a]SRH was dichotomized as poor SRH ('fairly poor' or 'poor') vs. good or average SRH ('very good', 'fairly good' or 'average')
[b]Reference group: community-dwelling respondents
[c]Product terms were added to the final model each one at a time

Table 4. Associations of chronic conditions and functional status with poor SRH by living situation and depression, based on logistic Generalized Estimating Equations analysis (GEE).

	Non-depressed		Depressed		Living at home		Institutionalized	
	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
Time (0-9 years)	0.94 (0.80;1.10)	.439	0.87 (0.69;1.10)	.250	0.95 (0.81;1.12)	.555	0.98 (0.82;1.17)	.849
Baseline age	0.86 (0.73;1.02)	.084	0.82 (0.66;1.03)	.091	0.80 (0.66;0.96)	.019	0.90 (0.75;1.08)	.258
Female gender	2.06 (0.85;5.00)	.111	0.65 (0.25;1.67)	.372	0.97 (0.46;2.03)	.931	1.50 (0.54;4.20)	.439
Number of chronic conditions (0-8)	1.18 (0.95;1.47)	.143	1.23 (0.90;1.67)	.195	1.30 (1.04;1.64)	.022	0.90 (0.65;1.25)	.532
Functional status (5-20)	1.33 (1.22;1.45)	<.001	1.17 (1.06;1.29)	.002	1.44 (1.29;1.60)	<.001	1.18 (1.08;1.28)	<.001
Depression					2.73 (1.39;5.39)	.004	1.19 (0.53;2.66)	.669
Institutionalized vs. community-dwelling	0.81 (0.40;1.65)	.564	0.49 (0.19;1.31)	.156				

institutionalized [56], we also examined whether dementia accounted for the moderating effect of living situation. Dementia was not associated with SRH, but being demented did moderate the effect of functioning: at similar levels of functioning, the cognitively impaired rated their health more positively.

Discussion

This study examined longitudinal change in the self-rated health of nonagenarians and its sensitivity to decline in disease and functioning. Our results showed clear average declines in SRH among the survivors that were followed for six or even nine years, whereas SRH remained stable in the short-term, i.e. within two years. Increased chronic conditions and declined physical functioning explained declines in SRH. The relationship of physical health with SRH is dependent on contextual factors and psychosocial functioning.

Of the nonagenarians in our study, 37% rated their health as fairly good or very good, compared to over 50% reported in previous studies in Denmark and China[29,31]. The observed disability levels in these previous studies are similar to that in our study, which either indicates differences in health measures other than disability or a different relation between other health indicators and SRH in those studies, which may be culturally determined[57]. Also, our middle category 'average' does not have a negative connotation in Finnish language and may be more often chosen than a middle category 'fair', which is commonly used in other studies. This might have resulted in less 'good'-raters in our study as compared to previous studies among nonagenarians. A study among 60-89 year-old Finns found that 39% rated their health as good, which is remarkably similar to what we found[58]. In view of a higher prevalence of chronic conditions and especially disability among nonagenarians, this similarity provides further evidence for a large gap between SRH and those other health measures with age.

Thus, SRH may be seen as rather positive, compared to disease prevalence and the level of functioning. Nevertheless, it proved sensitive to changes in disease and functioning, more pronounced on the longer than on the shorter term. The strong group level stability of SRH in those who were followed for two years is in line with previous studies among younger olds [17,34], and indicates that the gap between SRH and objectively measured health status may still be increasing at this age. It also indicates that nonagenarians may still be able to adapt to declines in health that occurred in those two years. Our results differ from those by Peng et al.[31], who showed predominantly worse health ratings within two years.

An average decline in SRH was apparent after six and nine years in this study. Declines that were observed on the long and short term were both explained by an increased number of chronic conditions and declined functioning. Accelerated declines in functioning after the age of 95 were found among nursing home residents[59]. If such strong declines occur among community-dwellers as well, it might be that on the long term adaptation mechanisms have become insufficient to counteract all health declines. At the same time, given a similar level of

functioning, older nonagenarians and those who were followed for a longer period seemed to rate their health better than younger ones. Previous research also showed that centenarians rated their health better than nonagenarians, even without adjusting for health problems[60]. Thus, even among nonagenarians age differences may exist in aspiration level or the level of social comparison[14,20], although long term changes in health eventually become apparent in SRH. Some caution is warranted with these conclusions, as the sample sizes, especially at the last wave, were quite low.

Older people consider being able to function normally or 'to do the things you want and need to do' as highly important when they judge their health[22,35]. Problems with functioning may be more apparent in everyday life, and as such may affect SRH to a larger extent than the number of diagnoses. Our results indeed showed that functional status had a stronger impact on poor SRH than the number of chronic conditions and also mediated part of the effect of chronic conditions on SRH[10]. The results furthermore showed that a dichotomy between poor and average or good SRH was more sensitive to the number of chronic conditions than the ordinal measure of SRH. Unfortunately, the sample size in our study did not allow studying all conditions separately, but we acknowledge that each may affect SRH in a different way.

Among the very old, depressive symptoms are prevalent, but remain often untreated[61]. In our sample depression was reported by 20% of the respondents, which is high compared to population-based estimates of clinically relevant depressive symptoms for the total older population of 55 years and older[62]. This difference might in part be explained by the higher age of our sample. But, more importantly, our respondents were asked whether their physician has told them that they suffer from depression or depressiveness. Responses to this question may include also depressive symptoms that are not clinically relevant. Jylhä has described depression as 'an important component of health in self-ratings, but it also modifies the framework of evaluation and may lead to a more negative interpretation of one's own situation'[1]. Our results confirmed that, also among the oldest old, there is an independent effect of depression on SRH, although this effect seemed less strong as compared to the effect of functional status. In the linear regression analysis, chronic conditions had a *stronger* effect on SRH among those with depression, which is in accordance with our expectations. The effect of functioning on poor SRH in the logistic regression was more pronounced among the non-depressed than among the depressed, although the association remained significant in both groups. It seems that the hypotheses we had regarding the moderating effect of depression cannot be directly translated to this study. It remains uncertain to what extent this can be attributed to our unique study population or to our more inclusive measure of depression. Future nonagenarian studies, which for example use a more commonly used depression scale, may further address the interrelationships between SRH, depression and chronic diseases and functioning.

Health decline represented by chronic conditions and functioning was less detrimental for people living in institutions than for people who lived in their own home. This finding is in line with our hypothesis that loss of function may have a larger impact on SRH among community-dwellers, because of the increased dependency that is accompanied with function loss. It might

also be that better health ratings among institutionalized people are due to downward social comparison, with people who are worse off[28,46,47,63]. Among the institutionalized were included also people living in an assisted living facility (9% of the total sample), but no information was available on the amount of care they received. To exclude possible classification bias, sensitivity analyses excluding people in assisted living facilities were performed, which yielded similar results. In addition, we explored what the effect of a higher prevalence of dementia in institutions might have been on the association between functioning and SRH. As in previous research[46], dementia was not associated with SRH. However, health ratings were more positive among the cognitively impaired, which might reflect the inability to integrate all mortality-relevant health information into a health rating[49].

An advantage of the current study is its longitudinal design. To our knowledge, long-term trajectories of SRH have not been studied before among the very old. Our results may indicate a causal relationship between changes in functional status and disease status with SRH. In addition, the inclusion of community-dwelling as well as institutionalized people may give a representative view of the total nonagenarian population.

A limited number of nonagenarians could be included in the longitudinal analyses, due to an annual mortality rate of nearly 20%[64]. Samples in 2007 and 2010 in particular were quite small, indicating that strong conclusions on long-term changes could not be drawn. Still, we think it is important to have analyzed these data since little is known about SRH changes in this age group. In cohort studies in the general older population the proportion of nonagenarians is usually too low to study them as a separate group. The Vitality 90+ Study is one of the few studies that enables studying the health and functioning of the oldest old, since all nonagenarians living in Tampere, Finland, are invited to participate.

Respondents included in our analyses are a selection of the healthiest of their birth-cohort. Further health selection occurred as well: mean SRH levels at baseline became gradually higher if people took part in more follow-up measurements (not shown). Sensitivity analyses also showed that the impact of diseases and poor functioning on SRH was larger among people who dropped out after 2003, compared with those that were followed for six or nine years. Health declines were probably more severe in these people, confirmed by the fact that most of them died before the next measurement wave. Mortality attrition occurs in the general population as well, and therefore may not affect the generalizability of our results to the Finnish nonagenarian population. The extent to which our results are applicable to future nonagenarian populations, or to those in different countries, remains uncertain. The rate of mortality in these populations, and also their perception of health, may differ from that in the present Finnish nonagenarian population.

A limitation of our study may be that the use of self-reported chronic conditions and our measure of depression has led to inaccuracies in this very old sample. When comparing self-reported with physician-reported conditions, nonagenarians more often under-reported some conditions than younger olds[30]. Regarding our measure of depression, studies have shown that a single-item measure of depression is closely related to a depression diagnosis[65] and is predictive

for mortality[66,67]. Earlier analyses in a subgroup of the Vitality 90+ Study indicated that compared to hospital records, nonagenarians themselves rather overestimate than underestimate both dementia and depression[30]. Likely, this is in part due to the wordings of the questions that did not require clinically confirmed diagnoses. However, studies have also shown that depressive symptoms and the early stage of dementia may be better identified by patients themselves than by their physicians[68,69]. The inclusion of people with mild or moderate cognitive impairment may have influenced our results as well. Still, SRH has been shown to predict mortality in this group[49], which indicates that SRH is a valid health indicator in this group. In addition, all SRH declines were explained by changes in physical functioning or chronic conditions, showing that SRH is a fair reflection of these measures of health and functioning. Finally, the last phase of life short-term health changes may be relevant and studies with a shorter follow-up period should give insight in this terminal decline, and how SRH reflects these changes.

Conclusion

Earlier studies demonstrated the validity of SRH in very old age by showing its predictive value for mortality[33,70]. The current study adds to this evidence by showing that SRH is sensitive to changes in disease and functioning, although more pronounced on the longer than on the shorter term. Within two years of follow-up, SRH was rather stable but eventually after six or nine years, the inevitable decline in functioning and chronic conditions became reflected in people's health ratings. These results imply that even in nonagenarians, SRH reflects declines in functioning and increases in number of chronic conditions. SRH may thus be used as a simple and pragmatic tool to assess changes in the overall health status of the oldest old.

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